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AN END ITEM MANUFACTURING PROCESS GUIDE

(A Functional Cost Analysis of Manufacturing Operations)

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The objective of this study was to develop a systematic procedure for pin-pointing areas for future funding requests aimed at improving production methods. The approach taken was to describe current manufacturing processes in terms of the <u>functions</u> they performed, thus allowing assessment of costs without reference to the methods employed. Such "technology-independent" assessment allowed cost comparison both within and among end items, thereby highlighting the high-cost functions.

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20. Abstract (Cont'd)

Based on available data a procedure was designed for developing the Process Analysis Structure - an interrelated set of nine tables which become the analyst's raw materials in the search for new combinations of operations and for high-cost production functions. This procedure including a new method for indirect cost allocation, was validated with actual data relating to the manufacture of the 105mm M68 gun tube.

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I. Background

Watervliet Arsenal was requested by Army Materiel Development and Readiness Command (DARCOM) to develop an "End Item Manufacturing Process Guide". The scope of work, as ultimately evolved, was to develop a systematic approach for pinpointing areas for future funding requests aimed at improving production methods. Thus, the guide would be used to determine which manufacturing elements or areas offered the greatest potential for the best return on capital investment for upgrading facilities, processes and equipment.

In order to satisfy its objectives, it was felt that the Guide should assist in the following kinds of tasks:

1. development of specifications for new technology;
2. evaluation of the feasibility of attaining high-volume production mixes, such as mobilization quantities;
3. cost and throughput comparison of alternative production methods;
4. rate of return analysis; and
5. analysis of various end items' competition for processing resources.

To accomplish such tasks, it would be necessary that the implementation of the guide incorporate time and cost data in a rather unconventional way, primarily due to the desire to utilize current data in a manner precluding concentration on the details of current technology. The latter concern was accommodated through development of the concept of

a "functional classification scheme" (FCS): by describing each current manufacturing activity or process in terms of the function being performed, it became possible to assess the current costs of performing the functions required to produce a given end item - without reference to the methods employed. By then comparing these "functional costs" both within and among end items, it was anticipated that high-cost functions would be pointed up for further Manufacturing Technology (MMT) effort. Moreover, the technological independence of the functional approach would assist in the assessment of commonality among various end-item manufacturing processes, competition for production resources, new-technology transferability, and so on.

A second major aspect of the approach was the development of a more truly representative method of indirect cost allocation. In brief, rather than assign the exact same indirect costing rate (as a function of direct labor hours) to all end items, a procedure was developed for assigning, in a direct manner, as many "indirect" costs as possible. This procedure would assist greatly in the determination of the true monetary value of a proposed manufacturing process improvement.

II. Approach

The study procedure consisted of six major steps:

1. A functional classification scheme was developed, to allow a generic definition for each of the processes used in the manufacturing of end items.
2. A "Process Analysis Structure" was developed by relating the information desired in the Guide to the data required to produce such information.

3. The available data sources were evaluated to determine their applicability in view of the data requirements derived in step (2).
4. A single end item was selected for validation purposes (the 105mm M68 tube).
5. Data were gathered for the 105mm M68.
6. The process analysis of the 105mm M68 tube was conducted, thus validating the data gathering procedures and the value of the Guide itself.

III. Results

A. Procedure

As a result of this study, an end item analysis procedure was designed consisting of three steps:

Step 1: Gather required data on manufacturing processes.
(Obtain and verify route sheet, component traveler, and time standards: prepare flow process chart; consolidate the data on the appropriate forms, and augment with functional descriptions and "move-type" information from process observation.)

Step 2: Gather the required data on indirect costs and prepare indirect costing rates.
(Obtain the necessary budget documentation; develop "position analysis tables" (which summarize the labor concentration in each production building), route sheet summary, building activities summaries; develop direct labor and indirect costing rate tables.)

Step 3: Generate the analytical reports.

(Prepare the data for computer analysis, verify inputs, run the applicable reports; hand-construct the appropriate column of the "Production Mix Feasibility Analysis".)

B. Structure of the Guide

In its current form, the Guide consists of nine tables or "Reports" use of which allows a systematic analysis and assessment of the production process for one or more end items. The names of these reports are:

Report 1 - Per Unit Function Cost by End Item
Report 2 - Function Costs for a quantity of - units
Report 3 - Labor Concentration by End Item Surface
Report 4 - Process Candidates for Combination
Report 5 - Process Candidates for Combination (regardless of action surface)
Report 6 - Per Unit Function Time vs. Process
Report 7 - Facilitating and Correcting Operations time Listing
Report 8 - Facilitating and Correcting Operations time Listing (Expansion)
Report 9 - Production Mix Feasibility Analysis

Report 1 shows the per end-item cost of each function required to produce that item, given today's production process. As a result, it allows comparison of both the absolute and relative costs of performing each of the functions. Report 2 is a constant multiple of Report 1; it multiplies each per-unit value in Report 1 by a fixed number of units of output of the end item in question. For a given level of manufacturing activity, then, the total cost of each function for a given end item may be assessed. Due to the use of a fixed functional classification

scheme, Report 2 may contain a number of end items of a given family (e.g., tubes) so that the effects of production mix on functional cost may be quantified; and the potential savings associated with functional cost reduction may be viewed within the perspective of a particular mix (e.g., mobilization).

Report 3 shows the labor concentration by surface, that is, the time and effort, both direct and indirect, expended on each surface of the end item. This report is designed to give insight into those locations or surfaces of the end item that are more than proportionately expensive to process or produce.

Reports 4 and 5 deal with the issue of process combination: They attempt to aid the analyst in discovering and evaluating the time/cost benefits of combining production activities which are compatible to combination. In Report 4, compatibility is couched in terms of "similar functions, similar hold and action surfaces". It is based on the assumption that two functions that take place on the same surface while the end item is being held in the same fashion are logical candidates for either sequential or simultaneous combination. Report 5 is similar to Report 4, except that action surface references have been eliminated, that is, the functions are sorted only by hold surface. This allows a more specific analysis of the process's candidates for sequential combination. Here we assume that if an end item is held in the same way for two or more

matching processes, and given that the constraints of process precedence are not violated, these processes should be performed in sequence without moving the end item.

Report 6 correlates function and process descriptions by displaying the cost of each process embodied by each function. The report allows a cost comparison of performing a given function through different processes, and may trigger attempts at technology transfer within the manufacturing cycle of a single end item or between end items.

Reports 7 and 8 show lists of "facilitating operations", to two degrees of detail. Since a facilitating operation is one which supports (or corrects) other operations, these reports indicate the source - and costs - of operations which are productive only in a limited sense and which should, if possible, be eliminated.

Finally, Report 9 lists all the available machine tools and the processing demands to be made upon each at a given mix level. It allows assessment of: (1) potential production bottlenecks of the mix in question; (2) substitutable equipment; and (3) the amount of additional equipment needed to satisfy the mix's requirement.

C. Synthesis

The validation study on the 105mm M68 tube shows several very interesting items. First, 12% of the time spent in producing the tube is consumed in

moving the tube about. Another 17% of the time is spent in making the tube ready for processing and removing the tube from one machine tool or another. Twenty-nine percent of the manufacturing time is spent facilitating a downstream operation or correcting a previous operation. Inspection and measurement by the operator, quality control, and quality assurance account for about 25% of the total cost. Finally 10% of the manufacturing costs involved exterior rough cuts indicating that a major cost reduction could result if the initial forging could be produced to tighter tolerances; while further savings might accrue if it were possible to implement the few process-combination candidates uncovered. It is estimated that detailed pursuit of the above areas could reduce the cost of manufacturing the 105mm M68 tube by up to 40%.

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